Application of Sports Equipment Image Intelligent Recognition Response APP in Sports Training and Teaching

Yang Ju[1,*]

[1] Department of physical education Tianjin University of Commerce, Tianjing 300134, China

Abstract

INTRODUCTION: The paper addresses the integration of intelligent technology in university physical education, highlighting the need for improved analysis methods for sports equipment image recognition apps to enhance teaching quality.

OBJECTIVES: The study aims to develop a more accurate and efficient APP use analysis method for sports equipment image recognition, utilizing intelligent optimization algorithms and kernel limit learning machines.

METHODS: The proposed method involves constructing an APP usage effect analysis index system, improving kernel limit learning machines through talent mining algorithms, and validating the model using user behavior data. The method integrates a talent mining algorithm to enhance the kernel limit learning machine (KELM). This integration aims to refine the learning machine's ability to accurately analyze the large datasets generated by the APP's use, optimizing the parameters to improve prediction accuracy and processing speed.

RESULTS: Preliminary tests on the sports equipment image intelligent recognition response APP demonstrate improved accuracy and efficiency in analyzing the APP's usage effects in physical education settings. The study compares the performance of the TDA-KELM algorithm with other algorithms like ELM, KELM, GWO-KELM, SOA-KELM, and AOA-KELM. The TDA-KELM algorithm showed the smallest relative error of 0.025 and a minimal time of 0.0025, indicating higher accuracy and efficiency. The analysis highlighted that the TDA-KELM algorithm outperformed others in analyzing the usage effects of sports equipment image recognition apps, with lower errors and faster processing times.

CONCLUSION: The study successfully develops an enhanced APP use analysis method, showcasing potential for more accurate and real-time analysis in the application of sports equipment image recognition in physical education.

*Corresponding author. Email: juyang@tjcu.edu.cn

1 Introduction

With the continuous innovation of the concept and mode of higher education in the new era, education informatization and intelligent technology continues to develop, based on new media, artificial intelligence technology, intelligent education teaching aids have gradually been introduced into university physical education [1]. For the application of intelligent education teaching aids in university sports, research on how to promote the integration and development of traditional sports teaching and modern intelligent education technology means, improve the effect of the use of artificial intelligence technology means in sports teaching, and comprehensively improve the quality of education and teaching has become a hotspot in the current university intelligent sports development research [2]. Intelligent sports identification response APP, as one of the intelligent sports auxiliary equipment platform, not only expands the application style of intelligent technology in physical education, but also improves the means of cultivating college students' awareness and behavior of participating in physical exercise [3]. As one of the key technologies in the design and application of intelligent sports recognition and response APP, the analysis of the application effect of intelligent sports recognition and response APP in university sports teaching can improve the efficiency of intelligent sports recognition and response APP on the one hand, and improve the design ideas and solutions of intelligent sports recognition and response APP on the other hand [4]. Therefore, the analysis method of intelligent sports recognition answering APP and the evaluation method of application effect have been paid attention to and studied by APP software designers, APP teaching and application personnel, scholars and experts [5]. The research of intelligent sports equipment image recognition answering APP teaching application analysis method includes the construction of intelligent sports equipment image recognition answering APP analysis index system and the establishment of effect analysis model algorithm [6]. Currently, the research on the teaching application of intelligent sports equipment image recognition answering APP includes APP application analysis [7], APP design improvement [8], APP application evaluation indexes [9], APP evaluation algorithms [10] and so on. Literature [11] used Keep exercise software to intervene in students' exercise, analyzed the students' strength quality, speed quality and endurance quality before and after the intervention application, and used the Extreme Learning Machine network to construct the application analysis model, which improved the students' mastery of APP use technology and developed good exercise habits; Literature [12] used the third-party application of fitness guidance APP for smartphones or wearable devices. It analyzed the situation of users recording fitness data, guiding sports learning, configuring sports resources, and leading a healthy lifestyle; Literature [13] analyzed the feeling of using the intelligent recognition response APP for sports equipment images from the three aspects of the APP function experience, interaction, and content experience, combined with the shallow neural network technology; Literature [14] optimized the parameters of the support vector machine using the particle swarm optimization algorithm to build a intelligent sports APP use analysis model, input APP use analysis model from five dimensions of expectation confirmation, satisfaction, perceived ease of use, perceived usefulness and trust; Literature [15] analyzes the driving factors of sports equipment fitness APP use, and constructs the APP application analysis system and model considering five dimensions of habit, game sense, health consciousness, performance sense value and price value; Literature [16] analyzes the use of fitness sports APP in extracurricular physical exercise monitoring and proposes the use evaluation effect analysis method based on intelligent algorithm optimization depth network. Although the design and application of sports APP has been widely used, the expansion of the functions of sports APP software and the analysis of the application effect still needs to be solved and developed and researched [17]. Currently, the APP application effect analysis method still has the following limitations [18]: less application in the sports equipment image recognition response APP, the analysis accuracy is not high enough, the real-time is poor, and the machine learning method parameter optimization algorithm can easily fall into the local optimum. With the rapid development of artificial intelligence technology and machine learning algorithms, the APP application effect analysis method combining intelligent optimization algorithms and neural network algorithms has also been the attention and research of experts and scholars in the professional field [19], especially from the perspective of APP application effect analysis model algorithms [20] and the feature indicator system [21], to improve the APP application effect analysis method generalization, application analysis accuracy and real-time.

Aiming at the limitations of the above mentioned intelligent sports APP teaching application analysis methods and the low generalization of the application effect of sports equipment image recognition response APP, this paper proposes the combination of talent mining heuristic optimization algorithm and kernel limit learning machine to analyze the application effect of sports equipment image recognition response APP in college students' physical education teaching. Due to the subjectivity and empirical selection of the kernel function parameters and regularization coefficients of the kernel limit learning machine [21], the talent mining algorithm is used to optimize the parameters of the kernel limit learning machine, and an analysis model of the teaching application of the sports equipment image recognition response APP is constructed based on the optimization of the kernel limit learning machine by the talent mining algorithm. Based on the dataset obtained from the sports equipment image recognition answering APP platform and the questionnaire,

empirical research is carried out, and the model is verified and analyzed by indicators and comparisons.

2 Intelligent Recognition Response App for Sports Equipment Images

The article analyzes and describes the functional composition of the smart recognition and reaction APP, and through the analysis of the application of the smart recognition and reaction APP function to college sports teaching, extracts the indicators for the analysis of the effect of the smart recognition and reaction APP based on the college sports teaching, and establishes the objective, scientific and systematic indicator system for the analysis of the effect of the APP.

2.1 Functional Composition of Intelligent Recognition Response APP

Sports equipment image recognition answering APP is a kind of application that takes the cell phone terminal as the communication carrier, based on the cell phone operation Xiyong, and transmits various sports equipment related services and information such as pictures, text, video, audio, etc. to the audience [22].

As an important entrance of human-computer interaction, the client function of APP for intelligent recognition and response of sports equipment images is an important link in the application mode of real intelligent sports service. The design of the intelligent sports equipment image recognition response APP function includes user client function, service personnel client function, administrator client function, and the specific structure composition is shown in Figure 1.

User client function through the Internet of Things equipment identity automatic identification system users can carry out user registration or identity automatic identification, rapid establishment of the user's digital health file, the use of sports equipment image automatic perception, recognition and analysis function, real-time recording of sportsman's movement information [23].

The service personnel client function utilizes the client to carry out interactive guidance for the exercise needs of exercise equipment users, providing remote and professional service products for all types of exercise,

deriving characteristic exercise or health management products, and ultimately forming a quantitative, real-time, mobile guidance model [24].

The administrator client is mainly developed for university service equipment sports personnel managers, who assess and manage university sports students to ensure the quality of teaching staff in sports or health services [25].
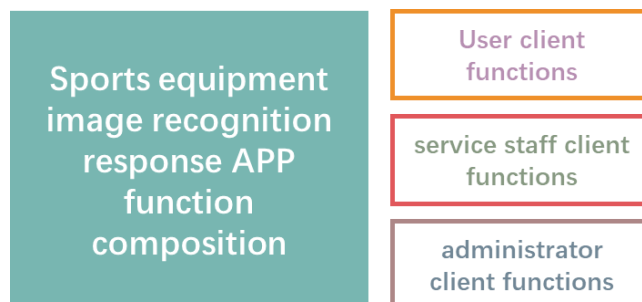
Figure 1 Composition of image recognition response app for sports equipment

2.2 Extraction of characteristic factors for analyzing the use of APP sports teaching

In order to construct the index system for analyzing the usage effect of APP for intelligent recognition of sports equipment images, the characteristic factors of APP sports teaching usage analysis are mainly analyzed and extracted from three perspectives, namely, users, service personnel, and administrators [26]. A4, health index monitoring and analysis A5; 2) service personnel: real-time online guidance B1, user index monitoring B2, personalized exercise prescription development B3, sports health guidance course development B4; 3) administrators: information review C1, service quality feedback C2, service information statistics C3, numerical control management C4. As the sports equipment recognition answer APP adopts the As the image recognition technology, it is good to extract the index factors of equipment: equipment sensor image acquisition D1, motion record back record D2, motion image recognition index analysis D3.The construction of the index system for analyzing the use effect of sports equipment image intelligent recognition answer APP is shown in Figure 2.
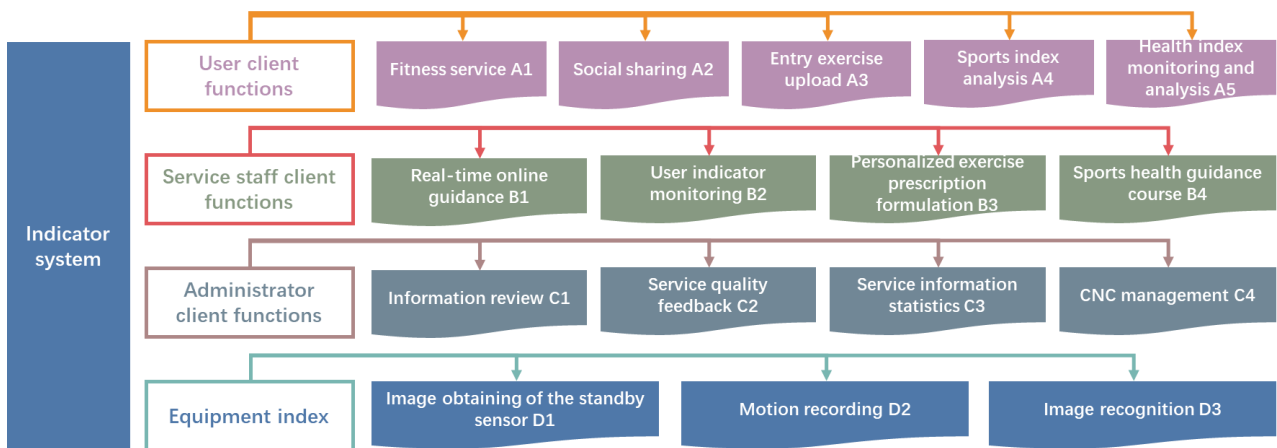
Figure 2 Indicators of physical health monitoring services

3 Related Technologies

3.1 Algorithm for talent discovery

(1) Inspired Mechanisms

Talent discoveral algorithm (TDA) [27] is a meta-heuristic algorithm based on human behavioral inspiration. Talent discoveral algorithm assists children in the process of exploring their strongest talents by modeling social groups. In the TDA social relationship, each child exhibits the strongest talent and the next most talented at different stages of development. The group represented by parents is called the talent mining set, and they will mine the child's talents based on the guidance of the strongest talent or the secondary talent. The group represented by grandparents is called the Gifted Explorers, who do not want to put too much pressure on their children and occasionally explore other areas of interest. The group represented by the tutoring organization is called the Interest Set. In the early stages of the child's development, they focus on exploring the child's interests in areas that are seldom touched upon, while in the later stages, they gradually change the focus of their exploration to explore in detail the strongest talent at the current stage. When a true talent is suspected to be discovered, the group will conduct further exploration around the interest set.

The strongest talent and the second best talent correspond to the optimal and sub-optimal solutions of the optimization function. The talent mining set enhances the development capability of TDA by digging deeper into the optimal and suboptimal solutions. The talent exploration set empowers TDA to escape from local optima. The interest set not only strengthens the exploration ability of TDA, but also is a decisive factor in balancing the exploration and exploitation ability of TDA.

(2) Mathematical modeling

1) Initialize the population

The 1st dimension of the solution space is divided into 4 regions, the 2nd dimension is divided into dimension 16 regions, and so on, using roulette to select the solution location uniformly, and then calculate the fitness value of all the solutions, i.e., calculate the talent value, the specific initialization decomposition diagram is shown in Figure 3.
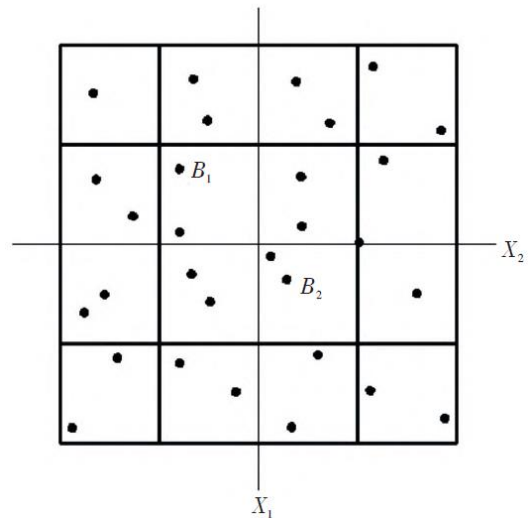

Figure 3 Initialization of talent discovery algorithm

2) Delineation of populations

The division of the population is mainly carried out according to the order of individual talent values from smallest to largest. Define the optimal and suboptimal solutions of the population as the strongest talent B_1 and the second best talent B_2 during the current iteration, and select the first N_1 solutions from the remaining solution sets according to the fitness value as the talent mining set, then

select the middle N_2 solution sets as the talent exploring set, and finally the remaining N_3 solutions as the interest set,

the schematic diagram of dividing the solution sets of the population is shown in Figure 4.

Figure 4 Population segmentation of talent discovery algorithm

3) Talent mining set location update

In the talent mining set subpopulation, the choice of actively following the last optimal or suboptimal solution is made by comparing the size of the random number t with the adaptive time threshold $P(g)$:

$$P(g) = \exp\left(\frac{1-g}{g_{\max} - g}\right) \quad (1)$$

Where, g is the current iteration number; $g_{\max}$ is the total iteration number; $P(g)$ varies in an exponentially decreasing manner as the number of iterations increases.

$$\begin{cases} X'_{(i)} = X_{(i)} + \left(X_b - X_{(i)}\right) \times N & t \geq P(g) \\ X'_{(i)} = X_{(i)} + \left(X_s - X_{(i)}\right) \times N & t < P(g) \end{cases} \quad (2)$$

Where $X'_{(i)}$ denotes the updated solution set; $X_{(i)}$ denotes the solution set before updating; X_b denotes the optimal solution; X_s denotes the suboptimal solution; t denotes the uniform random number within $(0,1)$; N denotes the uniform random number within $(-1,2)$.

4) Talent Quest Set Location Updates

Updating population positions in a subpopulation of the gifted exploration set using a randomized variable-large step-size strategy:

$$X'_{(i)} = X_{(i)} + \left(X_b - X_{(i)}\right) \times levy(\lambda) \quad (3)$$

where $levy(\lambda)$ denotes the Levy flight randomization step.

5) Interest Set Location Updates

In the interest set sub-population, by comparing the size between the random number t and $P(g)$, the random

wandering in the range of the least solution set is favored in the pre iteration period, and the deep development of the optimal solution of the previous stage is gradually strengthened in the later period, and a random perturbation of itself is carried out under the suspected falling into the local optimal situation to provide help in escaping from the local optimal solution, and the specific updating rules are as follows:

$$\begin{cases} X'_{(i)} = area(lb, ub) & r < P(g) \\ X'_{(i)} = X_{(i)} + C_1 \times \left(X_b - X_{(i)}\right) & r \geq P(g) \end{cases} \quad (4)$$

where r denotes the uniform random number in $(0,1)$; $area(lb, ub)$ denotes the region with the least number of solutions in the exploration space; lb and ub are the upper and lower boundary values of the solution space, respectively; and C_1 denotes the uniform random number in $(-1,1.8)$.

Random perturbations for:

$$X'_{(i)} = X_{(i)} + 2C_2 \times rand(0,1) - C_2$$
$$if \quad r < P(g) \quad f_{g,b} = f_{g-n,b} \quad (5)$$

where $n = 1\square 20$, obtained empirically; $f_{g,b}$ denotes the optimal solution at g iterations; $f_{g-n,b}$ denotes the first n optimal solutions at g iterations; and C_2 denotes the uniform random number within $(-1,1.2)$.

6) Boundary restriction strategy

The solution is updated at each iteration, and if the value of a dimension is greater or less than the set upper and lower boundary values, the boundary restriction strategy is applied:

$$X_{(i,k)} = unifrnd\,(lb, ub)$$
$$if \quad X_{(i,k)} > ub \,\|\, X_{(i,k)} < lb \tag{6}$$

where $X_{(i,k)}$ denotes the value of the ith solution in the kth dimension.

(2) Algorithm flowchart

According to the optimization strategy of DTA algorithm, the flowchart of DTA algorithm is shown in Figure 7. During each iteration, an initial solution is randomly generated, and the final optimal solution is continuously obtained by evaluation with greedy selection strategy.
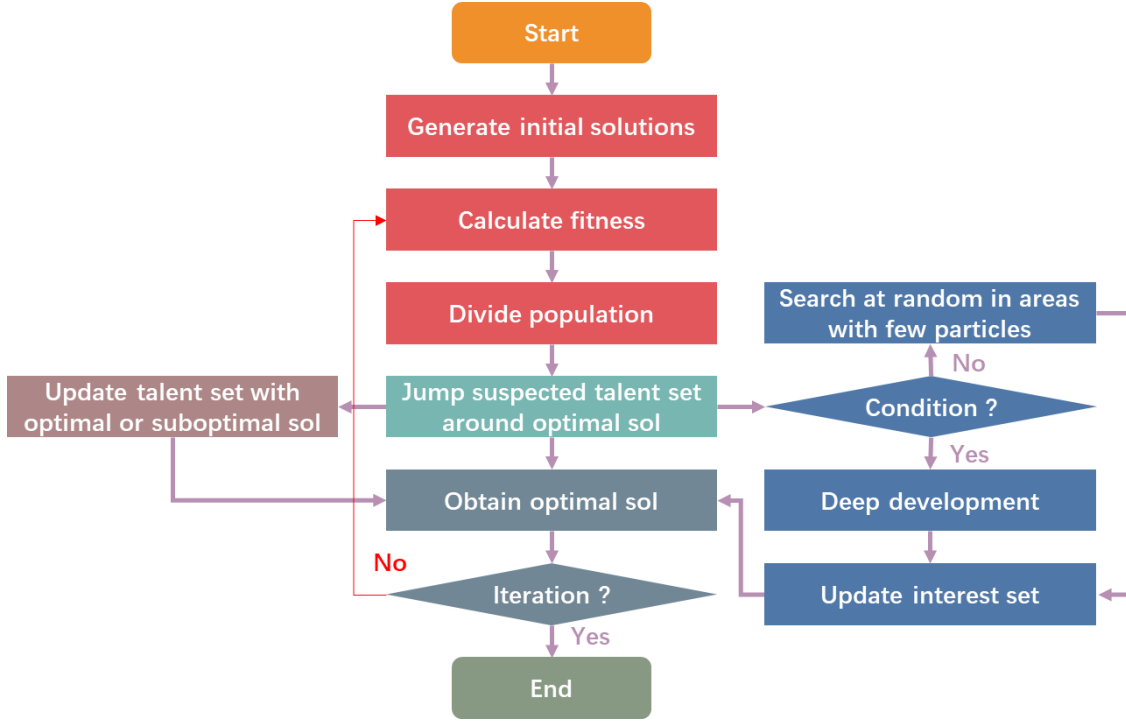

Figure 7 Flowchart of TDA algorithm

3.2 Nuclear Limit Learning Machine

(1) Extreme Learning Machine

The Extreme Learning Machine [28] is a single hidden layer feedforward neural network whose biggest advantage is its fast learning speed, and its structure is schematically shown in Figure 6. For a l hidden layer node the ELM can be expressed as

$$f_{ELM}(x_i) = \sum_{j=1}^{l} \beta_j g(a_j x_i + b_j), i = 1, 2, \cdots, N \tag{7}$$

Where $\beta_j = [\beta_{j1}, \beta_{j2}, \cdots, \beta_{jn}]$ denotes the output weight of the j th hidden layer unit, $a_j = [a_{j1}, a_{j2}, \cdots, a_{jm}]$ denotes the input weight of the j th hidden layer unit, b_j denotes the bias of the j th hidden layer unit, and $g(\cdot)$ denotes the activation function of the hidden layer unit.
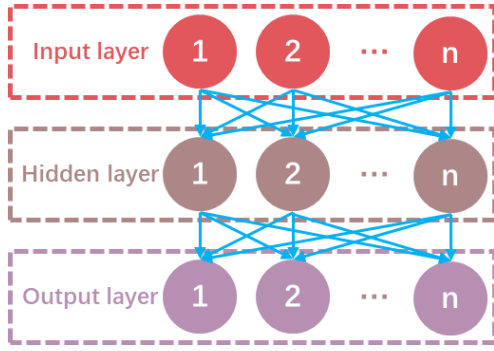
The ELM output error is

$$E = \sum_{i=1}^{N} \left\| f_{ELM}(x_i) - y_i \right\|$$
$$= \left\| H(a, b) \cdot \beta - y \right\| \tag{8}$$

Where, H denotes the output of the hidden layer unit, β denotes the output weight and y denotes the desired output. In ELM algorithm, by determining a and b, H is uniquely determined. The output weights are solved by the equation

$$\beta^* = H^{-1} \cdot y \tag{9}$$

where H^{-1} denotes the Moore-Penrose generalized inverse matrix of the matrix H.

Figure 6 Structure of Extreme Learning Machine

(2) Nuclear Limit Learning Machine

In order to increase the accuracy of the ELM network model, this paper combines the kernel function and uses the Kernel Extreme Learning Machine (KELM) [29] to construct the APP application effect analysis model, and the structure of the KELM algorithm is shown in Figure 7 as follows:

First, the kernel matrix is defined according to Mercer's condition:

$$\begin{cases} \Omega_{ELM} = \boldsymbol{HH}^T \\ \Omega_{i,j} = h(x_i) \cdot h(x_j) = K(x_i, x_j) \end{cases} \quad (10)$$

Among them, $\boldsymbol{H}$ is the hidden layer output matrix; $h(x)$ is the hidden layer node output function; $K(x_i, x_j)$ is the kernel function, the kernel function will affect the decoupling performance of the model, considering the radial basis of the kernel function parameters are less and has a good nonlinear processing ability, can be better adapted to the APP application effects of analyzing the changes in the various influencing factors related to this paper, the radial basis of the function is selected:

$$K(x_i, x_j) = \exp\left(-\frac{\|x_i - x_j\|^2}{\gamma^2}\right) \quad (11)$$

where γ is the kernel function parameter and I/C is added to the main diagonal of $\boldsymbol{HH}^T$ so that its characteristic root is not 0. The output function of the KELM analysis is:

$$f(x) = h(x)\boldsymbol{H}^T\left(\frac{I}{C} + \boldsymbol{HH}^T\right)^{-1}\boldsymbol{T}$$
$$= \begin{bmatrix} K(x, x_1) \\ \cdots \\ K(x, x_N) \end{bmatrix}^T \left(\frac{I}{C} + \Omega_{ELM}\right)^{-1}\boldsymbol{T} \quad (12)$$

where C is the regularization coefficient, I is the unit matrix, and $\boldsymbol{T}$ is the output vector.

In summary, the kernel function parameters γ and regularization coefficients C are important factors affecting the performance of KELM analysis.
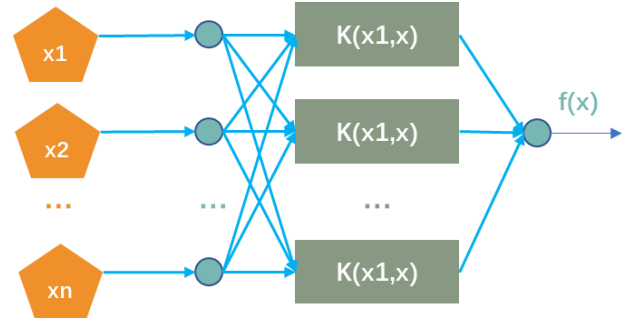

Figure 7 KELM structure

4 Improvement of KELM network based on TDA algorithm image intelligent recognition response APP sports teaching using method ideas

(1) Coding method

In order to improve the accuracy of the KELM neural network, the TDA algorithm is used to optimize the parameters of the KELM neural network, i.e., optimizing the weights and biases of the hidden layer of the neural network, the kernel function parameters γ and the regularization coefficients C, and this paper adopts the real number coding method to encode the hidden layer parameters, the kernel function parameters, and the regularization coefficients, the specific coding method is shown in Figure 8. From Figure 8, it can be seen that the encoding region is mainly divided into the hidden layer weights and hidden layer bias, kernel function parameters, and regularization coefficients.
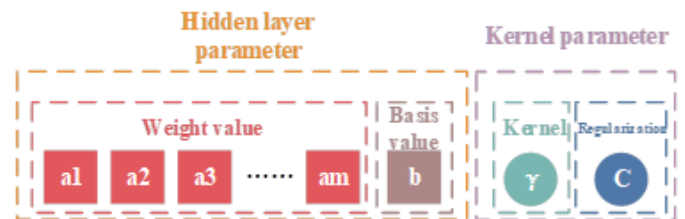
Figure 8 Encoding of KELM parameters

(2) Adaptation function

In order to accurately reflect the training KELM network strengths and weaknesses, this paper uses the root

mean square error (RMSE) as the fitness function, which is calculated as follows:

$$RMSE = \sqrt{\left(\sum_{i=1}^{M}(\hat{y}_i - y_i)^2\right)\Big/ M} \qquad (13)$$

Where M is the number of observed samples, $\hat{y}_i$ and y_i denote the true and predicted values of the sample i respectively.

(3) TDA-KELM Method Steps and Processes

According to the coding method and the fitness function, the flow chart of the method for analyzing the effect of the use of the nuclear limit learning machine APP based on the talent discovery algorithm is shown in Figure 9, and the specific steps are as follows:

Step 1: The raw data is preprocessed and normalized into test set, training set & validation set;

Step 2: The TDA algorithm encodes the initial parameters of the KELM, and also initializes the algorithm parameters such as population parameters, iteration number, etc.; the population is initialized, and the value of the fitness function is computed according to Equation (13);

Step 3: According to the fitness value ranking strategy, the population is divided into talent mining set, talent exploration set, and interest set; and the individuals are updated according to the optimization strategy for different population sets;

Step 4: Calculate the fitness function value and update the global optimal solution, individual optimal solution;

Step 5: Judge whether the termination condition is satisfied. If satisfied, exit the iteration, output the optimal network parameters, and execute step 6, otherwise continue to execute step 3;

Step 6: Decode the parameters of the TDA-based optimization network to obtain the hidden layer unit weights and biases, kernel function parameters, and regularization coefficients of the kernel limit learning machine network;

Step 7: Construct the TDA-KELM network, use the training set to train the network to get the effect analysis model, and input the test set into the effect analysis model to get the analysis results.
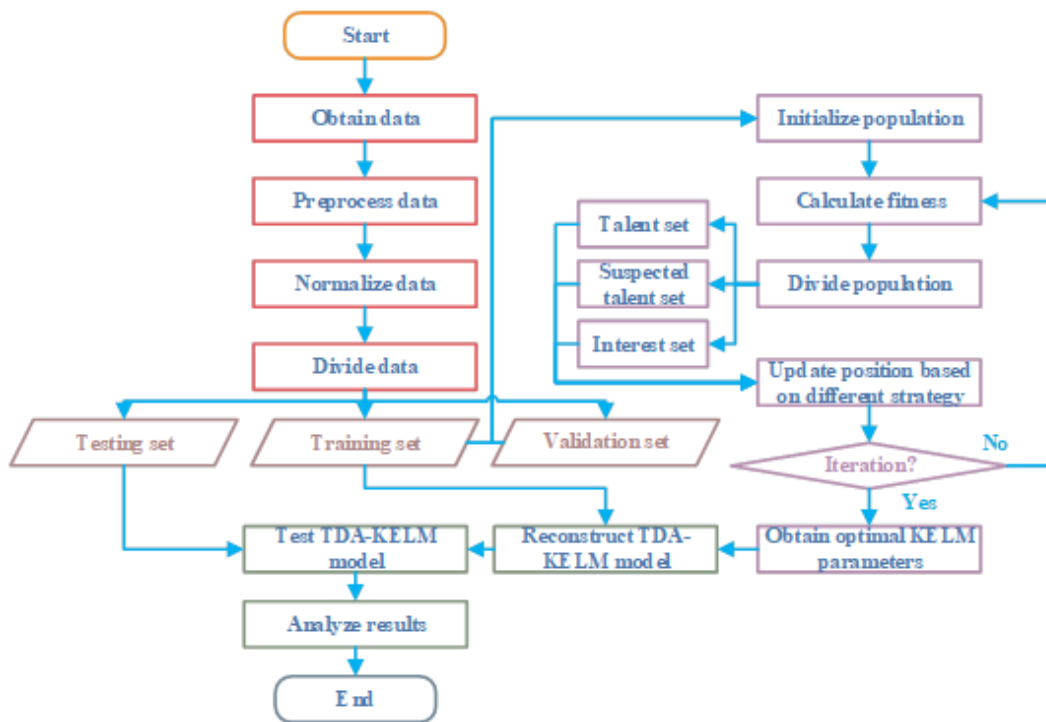

Figure 9 Method for analyzing the effect of APP instructional use based on TDA algorithm optimizing KELM network

5 Experiments and analysis of results

In order to verify the effectiveness and efficiency of the APP teaching utilization effect analysis method based on TDA algorithm optimization of KELM network proposed in this paper, this section selects the records of sports equipment image recognition APP platform and questionnaire data to analyze and discuss the results of the utilization effect analysis of the proposed algorithm.

5.1 Experimental environment setup

In this paper, MATLAB 2021a is used for program writing, and the test environment is Windows 10 system, the processor is AMD Ryzen 9 5900HX with Radeon Graphics, and the RAM is 16.0GB.The experimental dataset is selected as the record and survey of the APP platform for sports equipment image recognition from January 2023 to November 2023 The questionnaire data is used as the training set for the APP analysis model, and the data from December 2023 is used as the test set for the APP analysis model.

5.2 Method parameterization and analysis

(1) Algorithm parameterization

In order to verify the advantages and disadvantages of the algorithms proposed in this paper for the analysis of APP utilization effects, five algorithms are selected for comparison, and the specific parameter settings of each algorithm are shown in Table 1, in which GWO-KELM, SOA-KELM, AOA-KELM, and TDA-KELM optimize the parameters of the KELM network using the intelligent optimization algorithm; the parameters of the ELM and the KELM are not optimized, and they are determined using empirical settings ; GWO , SOA, AOA, and TDA algorithm population sizes are analyzed in the next subsection and the number of iterations is 500.

Table 1 Parameter settings of the analysis algorithm for APP usage

arithmetic	parameterization
ELM	Hidden layer node is 50, activation function is radial basis function
KELM	Hidden layer node is 50, activation function is kernel function, kernel function parameter is 0.01, regularization factor is 100
GWO-KELM	α decreases linearly to 0, r1,r2 ∈ [0,1]
SOA-KELM	The value of the control parameter of the SOA algorithm decreases linearly from 2 to 0 as the number of iterations increases.
AOA-KELM	C1=2, C2=6, u=0.9, l=0.1, C3=1, C4=2
TDA-KELM	Parameter-free optimization

(2) Parameter impact analysis

In order to analyze the impact of the population size of TDA algorithm and the number of hidden layer nodes of KELM network on the APP usage analysis method, this paper compares and analyzes the performance of the APP usage analysis method under the conditions of different population sizes and different numbers of hidden layer nodes of the network, respectively. Figure 10 and Figure 11 give the graphs of the influence of different population sizes and different numbers of network hidden layer nodes on the accuracy and time of the APP usage analysis method, respectively.

As can be seen from Figure 10, as the population size of the TDA algorithm increases, the RMSE value of the sports equipment image intelligent recognition answering APP using analytical method analysis gradually decreases; at the same time, as the number of hidden nodes of the KELM algorithm increases, the RMSE value of the sports equipment image intelligent recognition answering APP using analytical method analysis gradually decreases. Through the above analysis, it can be seen that the more hidden nodes, the larger the population size, the smaller the RMSE value of sports equipment image intelligent recognition answering APP using analysis method analysis, and the higher its accuracy.
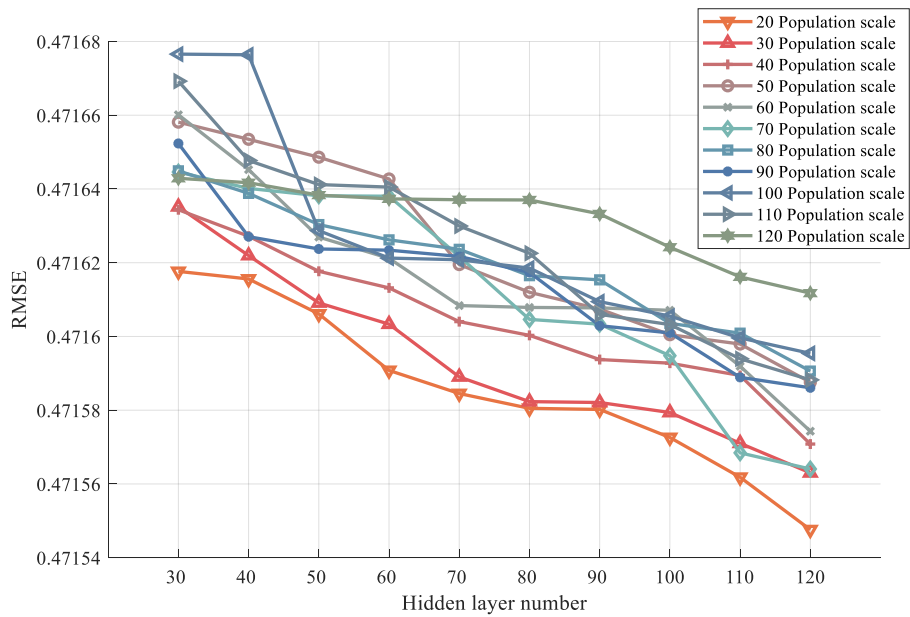
Figure 10 Effect of different population sizes and number of hidden nodes on the RMSE of APP usage analysis methods

From Figure 11, it can be seen that as the number of populations of the TDA optimization algorithm increases, the analysis time of the sports equipment image intelligent recognition answering APP using the analysis method also increases gradually; as the number of hidden nodes of the KELM algorithm increases, the analysis time of the sports equipment image intelligent recognition answering APP using the analysis method also increases gradually. Through the above analysis, it can be seen that the more hidden nodes, the larger the size of the population, the larger the analysis time of the sports equipment image intelligent recognition answering APP using the analysis method, and the worse its real-time performance.
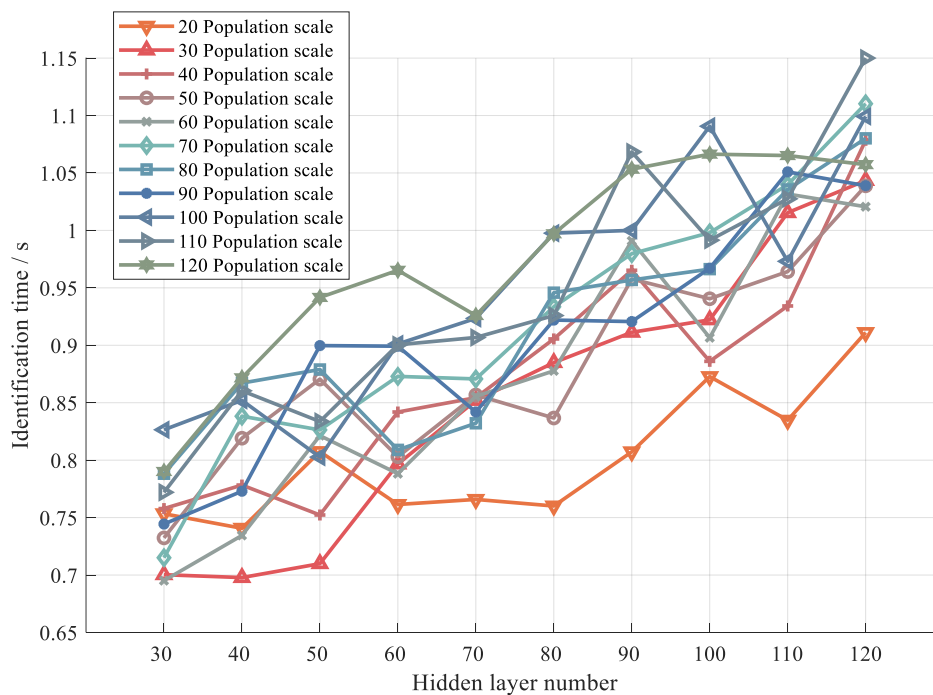
Figure 11 Effect of different population sizes and number of hidden nodes on the analysis time of APP using analytical methods

In summary, the population size of the TDA optimization algorithm selected in this paper is 50 and the number of hidden nodes in the DBN network is 80.

5.3 Performance analysis of TDA algorithm optimization

In order to verify the performance of the proposed TDA algorithm, the variable dimensional multi-peak benchmark function is selected in this section to analyze the convergence of the TDA algorithm, and the results are shown in Figure 12. The shape of the test function, the particle search history graph, and the convergence curve are given in Figure 12. From Figure 12, it can be seen that a number of solution sets are randomly distributed in the search space and present a search trajectory, while all of them will eventually enclose the global optimal solution. This is due to the uniform initialization strategy of TDA and the unique random wandering and self-perturbation strategy of interest sets. This strategy helps TDA to carry out the exploration of the search space rapidly. As the number of iterations increases and the suspected optimal solution emerges, TDA in turn gradually strengthens the local exploitation capability and deepens around the optimal value, while at the same time decreasing the exploration intensity.
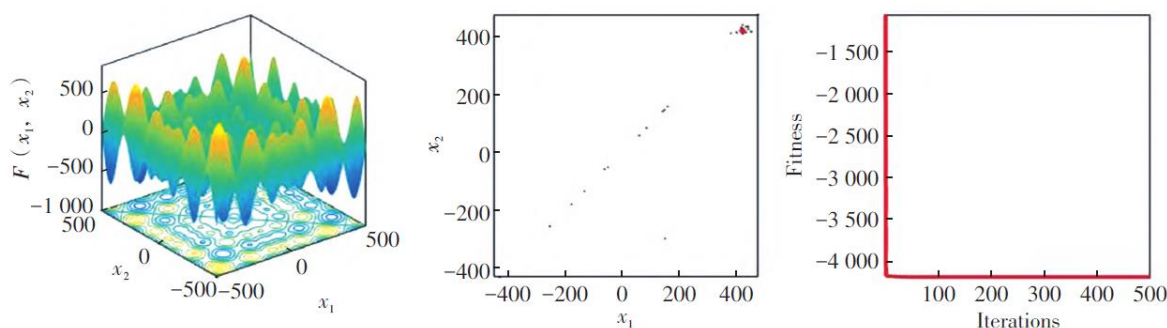

**Figure 12** Experimental results of TDA convergence analysis

5.4 Applying algorithmic performance analysis

In order to verify the effectiveness and superiority of the APP usage analysis method based on the TDA-KELM algorithm for intelligent recognition of sports equipment image response, the APP usage analysis method based on the TDA-KELM algorithm is compared with the ELM, KELM, GWO-KELM, SOA-KELM, and AOA-KELM algorithms, and the performance results of each model are shown in Figs. 13 and 14, 15 are shown. Figure 13 gives the results of comparison of the analysis values of the sports equipment image intelligent recognition answering APP using the analysis methods based on each algorithm, respectively. As can be seen from Figure 13, the difference between the analysis value of the sports equipment image intelligent recognition response APP usage analysis method based on the ELM algorithm and the real value is large, and the maximum error reaches 0.25; the error between the analysis value of the sports equipment image intelligent recognition response APP usage analysis method based on the KELM algorithm and the real value reaches 0.2 at most, and some of the samples have the same analysis results as the real results; Based on GWO-KELM algorithm, the error between the analysis val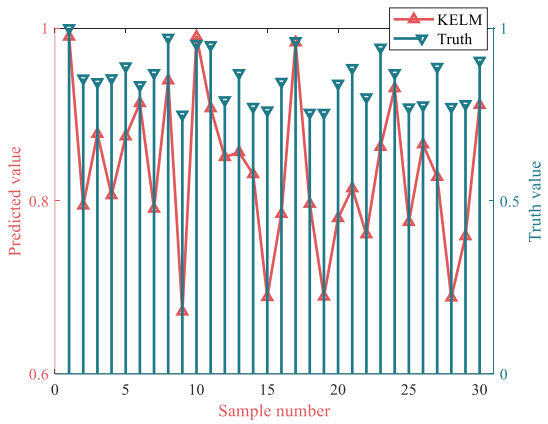ue and the real value of the sports equipment image intelligent recognition answer APP using the analysis method becomes smaller, and the analysis results of a small number of samples are consistent; based on SOA-KELM algorithm, the error between the analysis value and the real value of the sports equipment image intelligent recognition answer APP using the analysis method is controlled to be within 0.2; based on AOA-KELM algorithm, the error between the analysis value and the real value of the sports There is a certain difference between the error between the analysis value and the real value of the sports equipment image intelligent recognition answer APP using the analysis method, and a small number of samples have been analyzing the value and the real value; the error between the analysis value and the real value of the sports equipment image intelligent recognition answer APP using the analysis method based on the TDA-KELM algorithm is relatively small. It can be seen that the TDA-KELM algorithm to solve the sports equipment image intelligent recognition response APP use analysis problem is more suitable, making the analysis more accurate.
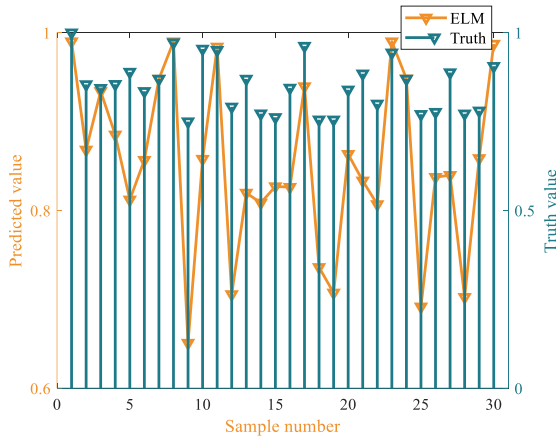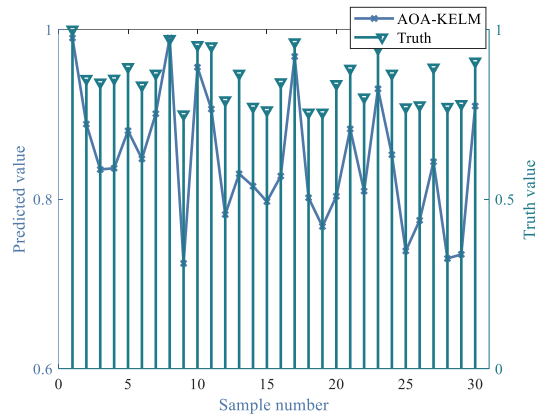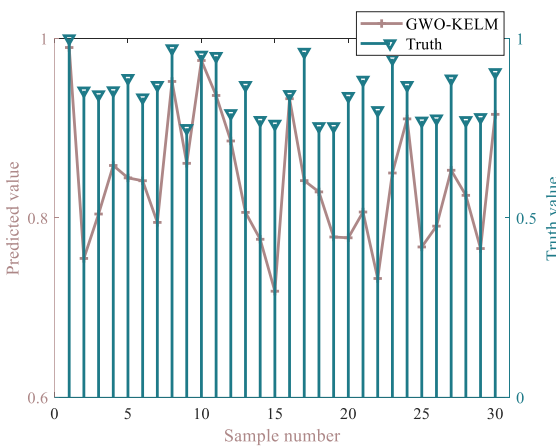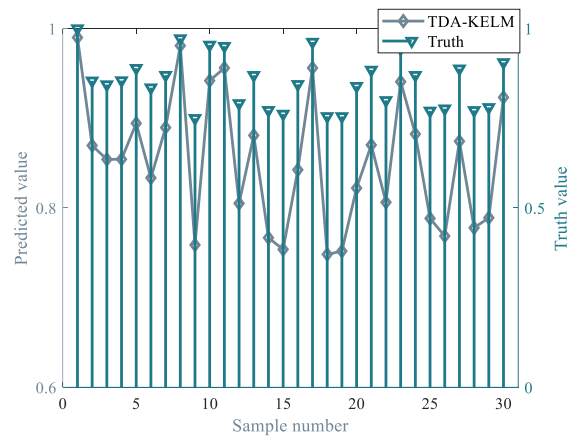
(a) ELM
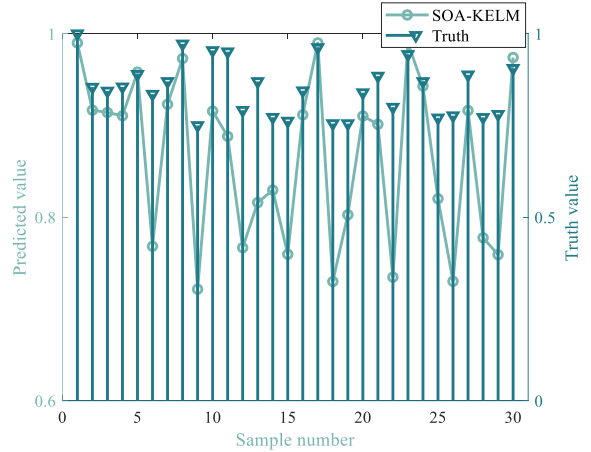
(b) KELM

(c) GWO-KELM

(d) SOA-KELM

(e) AOA-KELM

(f) TDA-KELM

Figure 13 Comparison results of analysis and real value of APP usage analysis method based on each algorithm

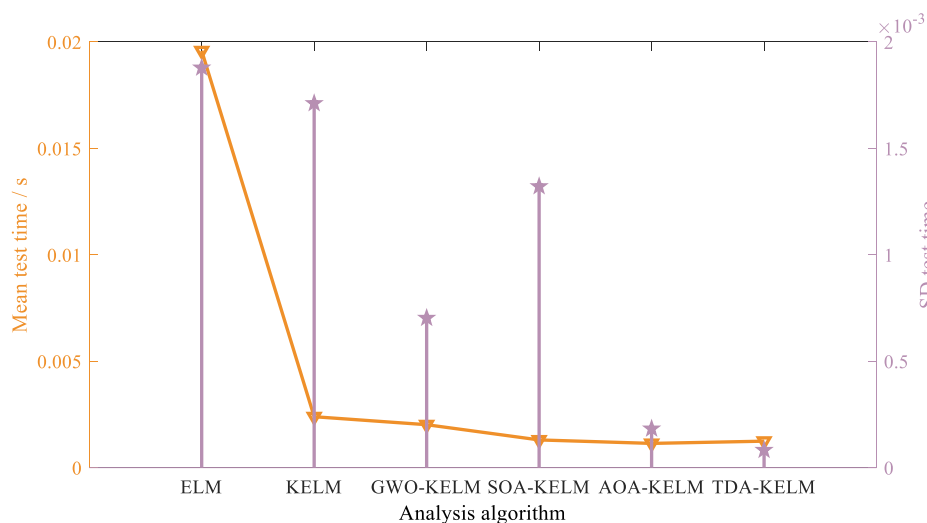The results of the comparison of the relative errors of the sports equipment image intelligent recognition answering APP usage analysis methods based on each algorithm are shown in Figure 14. It can be seen from Figure 14 that the relative errors of the sports equipment image intelligent recognition answering APP usage analysis

methods based on the ELM, KELM, GWO-KELM, SOA-KELM, AOA-KELM, and TDA-KELM algorithms are controlled within the ranges of 0.085, 0.08, 0.09, 0.075, 0.06, 0.025; the analysis error of the sports equipment image intelligent recognition response APP use analysis method based on ELM algorithm is the largest; the analysis error of the sports equipment image intelligent recognition response APP use analysis method based on TDA-KELM algorithm is the smallest. Comparing GWO-KELM, SOA-KELM, AOA-KELM and TDA-KELM, TDA can improve the performance of KELM parameter optimization; comparing ELM, KELM, kernel function can improve the analysis accuracy of the analysis method of sports equipment image intelligent recognition response APP use.
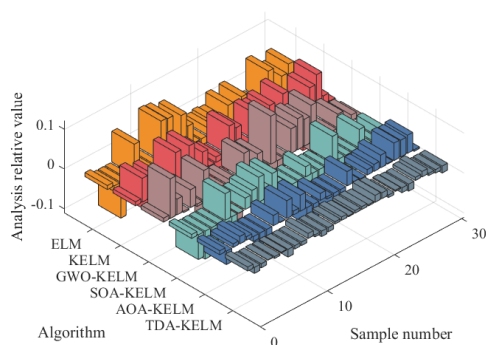
Figure 14 Relative error results between the analysis and the real value based on each algorithm's APP usage analysis method analysis

The results of the comparison of the analysis time of the APP usage analysis methods based on each algorithm for intelligent recognition of sports equipment image response are presented in Figure 15. As can be seen from Figure 15, the ranking of the mean value of the analysis time of the APP usage analysis methods based on each algorithm is TDA-KELLM, AOA-KELLM, SOA-KELM, GWO-KELM, KELM, ELM algorithm, and the ranking of the standard deviation of the analysis time of each algorithm is TDA-KELLM, AOA-KELLM, GWO-KELM, in the order of the standard deviation of the analysis time of each algorithm, SOA-KELM, KELM, and ELM algorithms. It can be seen that the TDA-KELLM algorithm has the least mean analysis time, the smallest standard deviation, and the best real-time robustness.

Figure 15 Recommendation time results of music recommendation methods based on each algorithm

6 Conclusion

Aiming at the defects of insufficient analysis accuracy and effect of the current sports equipment image intelligent recognition answering APP usage analysis method, this paper researches the sports equipment image intelligent recognition answering APP usage effect analysis index system, proposes an APP usage analysis method based on the intelligent optimization algorithm to improve the kernel-limit learning machine, and tests it on the sports equipment image intelligent recognition answering APP user behavioral dataset and get the following conclusions:

1) The kernel function improves the training of the extreme learning machine, which makes the APP use analysis with more accuracy and less time;

(2) TDA was used to optimize the KELM parameters to achieve the construction of the APP use analysis model, and compared with the real results, the relative errors of the APP use analysis method were controlled within the range of 0.025 and the time reached within 0.0025, respectively.

In this paper, the proposed method uses the TDA algorithm to optimize the KELM making the recommendation efficiency subject to certain limitations. In future work, the optimization of KELM method will be considered to improve the analysis efficiency of the algorithm.

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